1. Rusne flood waterlevel of 1% and 10% probability is acquired via fitting of the annual maximum water level data series at Rusne WMS by normal distribution. Data series from LEPA (2014) were used, they include 68 year observations in time period 1933-2010.

2. Rusne flood waterlevel of 50% probability was selected as median value of the data series of point (1).

3. Nemunas discharges of 1% and 10% probability at Rusne were calculated as follows:

    a. The probabilistic discharges at Nemunas-Panemune were obtained from LEPA (2014).

    b. The percentage of discharge through Gilijos branch was calculated from Pupienis at al (2012), Table 3 as 12.125%.

    c. The discharges at Rusne were calculated multiplying the discharges at Panemune (point 3a) with percentage of Gilijos discharge (point 3b).

4. Nemunas discharge of 50% probability was calculated as follows:

    a. The 50% discharge at Nemunas-Smalininkai was calculated as median of the maximum yearly discharges at Smlininkai from the time series from LEPA (2014). These time series contained data for Years 1958-2010.

    b. The discharge at Nemunas-Smalininkai was recalculated to discharge at Nemunas-Panemune assuming that discharge is proportional to the catchment area of respective stations.

    c. The percentage of discharge through Gilijos branch was calculated from Pupienis at al (2012), Table 3 as 12.125%.

    d. The discharge at Rusne was calculated multiplying the discharge at Panemune (point 4b) with percentage of Gilijos discharge (point 4c).

The calculated probabilistic characteristics in Table 1 are an important enhancement of the data in Lietkelprojektas (1982). The higher accuracy of those probabilistic values are achieved because the essentially longer time series of the observations are available in our study.

All probabilistic waterlevels calculated in this report are lower as corresponding probabilistic waterlevels in Lietkelprojektas (1982). It might be associated with various natural and anthropogenic influences beyond the scope of the current study; most probable cause to our opinion is a general decrease of the spring flow maximum since 1979 due to changing climate.

Note, that in the area of interest the dependence of the water level on the discharge during the flood event is ambiguos. It is influenced by (1) sea waterlevel, (2) ice conditions in the river, (3) possible ice blockages, and (4) snow/ice conditions in the overflowing floodplain.

To resolve this ambiguity we assumed that the respective scenario (1% or 50% flood) is a synthetic flood event when a probabilistic discharge causes the waterlevel of the same probability at Rusne station. The methodics used to achieve this situation is described in Section 2.3.

2.3. MODEL CALIBRATION

The main goal of model calibration was in matching the flow distribution between Skirvyte, Pakalne, Atmata and right floodplain as well as waterlevel in observations Lietkelprojektas (1982) with the modeling results.

The scheme of the dividing of water flows is shown in Fig. 6. It corresponds both to reuqirements of this report and measurements in Lietkelprojektas (1982). It is associated with branches of Nemunas and segments of the overflooded road Šilute – Rusne:

a. Skirvyte branch, together with Pakalne branch.

b. Atmata branch, beneath the bridge over Atmata on the Šilute-Rusne road.

c. Road section "Road 1" between the bridge over Atmata and projected viaduct.

d. Road section "viaduct" in the place of proposed viaduct.

e. Road section "Road 2" between the proposed viaduct and more elevated road section.

f. Road section "Žalgiriai" along the more elevated road section.

g. Flow beneath the Griņius bridge referred as Sležu bridge in Lietkelprojektas (1982).

h. Sum of discharges in points (c) to (g) is referred as to "floodplain".

The calibration strategy was as follows:

1. The initial values of the Manning coefficients (surface roughness) was taken according to land cover, Kiselev (1976).

2. The calculations were performed for the [upstream] Nemunas discharge in flood event 1979 (Table 1).

3. The values of Manning coefficients were fine tuned AND the downstream boundary conditions (waterlevels) adjusted to match the observed and modeled model characteristics.

The calibration results are given in Table 2 (as match of the observed and modeled discharges and waterlevels), Fig.5 (as values of Manning's N coefficients) and in Table 3 (as downstream boundary conditions – waterlevels in Atmata and Skirvyte).

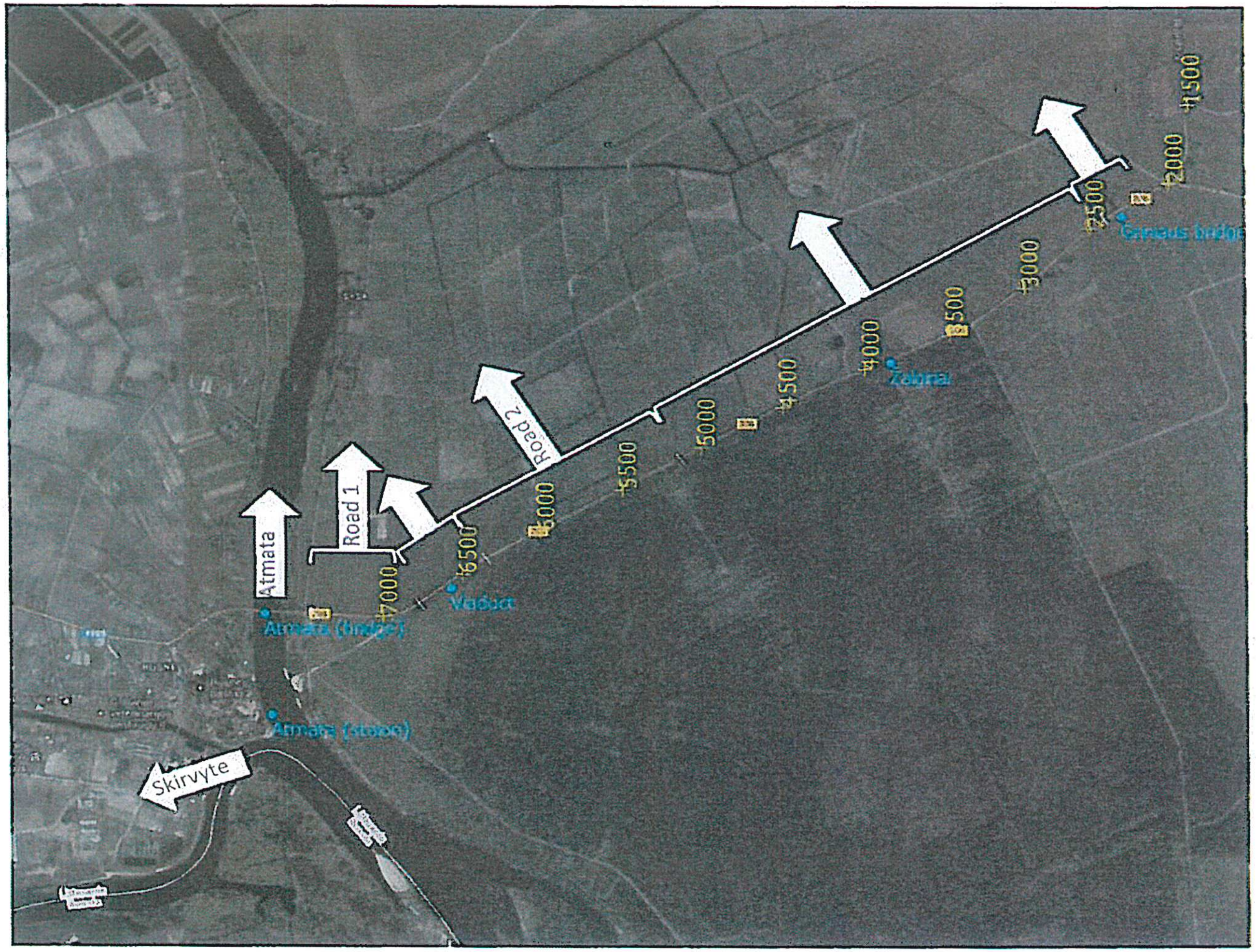

Fig. 6. Scheme of the flows in Nemunas branches and over the Šilute-Rusne road.

Table 2. Calibration results – comparison of the observed and modelled waterlevels and discharges.

Scenario		Water level, m				
		Atmata (station)	Atmata (bridge)	Viaduct	Žalgiriai	Griniaus bridge
1979	observed	2.40	-	2.23	2.20	2.18
	modelled	2.44	2.30	2.19	2.29	2.25

Scenario		Discharge																
		Skirvyte		Atmata		Road1		Viaduct		Road2		Žalgiriai		Griniaus bridge		Floodplain		Total
		m3/s	%	m3/s	%	m3/s	%	m3/s	%	m3/s	%	m3/s	%	m3/s	%	m3/s	%	m3/s
1979	observed	1363	38.9	947	27.0							0	0.0	305	8.7	1192	34.0	3502
	modelled	1403	40.1	942	26.9	177	5.1	408	11.7	149	4.2	6	0.2	417	11.9	1157	33.0	3502

The achieved fit of observed and modeled discharges should be considered as very good; the model overestimates the total discharge in Skirvyte/Pakalne by less than 3%. We may assume that this difference is less than measurement error. The distribution of the flow percentage through Škirvyte (with Pakalne) / Atmata / floodplain is almost a perfect match.

The discrepancy between observed and modeled waterlevels is better than 10 cm; it can be assessed as good, especially because the measurements took place during the course of several days. Thus, the model is calibrated and prepared for case studies in Chapter 3.

Table 3. Calibration results – downstream boundary conditions for all scenarios.

Scenario	Upstream discharge , m^3/s	Downstream water level, m	
	Nemunas	Skirvyte, Pakalne	Atmata
1%	5894	2.65	2.25
1979	3502	2.12	1.72
50%	1603	1.57	1.77

3. CALCULATION RESULTS

3.1. REFERENCE SITUATION

The calculation results for the reference (present terrain) situation are presented as

- Distribution of the waterlevel and flow velocity in the full modeling domain for the spring flood 1979 in Fig. 7.

- Distribution of the waterlevel and flow velocity in the vicinity of Šilute-Rusne road for 50% flood, spring flood 1979 and 1% flood in, respectively, Figs. 8-10.

- Discharge values through Nemunas branches and different segments of the Šilute-Rusne road for all scenarios and cases in Table 4.

- Water levels (Table 5) and flow velocities (Table 6) at different locations – under Atmata bridge, at the place of proposed viaduct and under the Griņius bridge.

- Longitudinal profile of Šilute-Rusne road with waterlevels and flow velocities for 50% flood, spring flood 1979 and 1% flood in, respectively, Figs. 11-13.

- Discharge distribution for 50% flood, spring flood 1979 and 1% flood between flow branches (Fig. 14) and over segments of Šilute-Rusne road (Fig. 15).

Fig. 7 indicates that the right floodplain of Nemunas dowmstram Gege confluence is almost fully flooded in 10% floods. The exceptions are few local more elevated areas including the Žalgiriai forest.

The longitudinal cross section of the road Šilute-Rusne (see Figs. 6 and 11-13) may be divided in the following parts:

(a) The bridge over Amata and associated viaduct.

(b) The curved stretch of height 190-200 cm between the Atmata bridge and extremely low section of the road (referred as "road1").

(c) The extremely low (around 100 cm) elevated stretch of the road. This is a road section where the building of viaduct is proposed (stretch referred as "viaduct")

(d) The low (around 200 cm) straight section of road (referred as "road2").

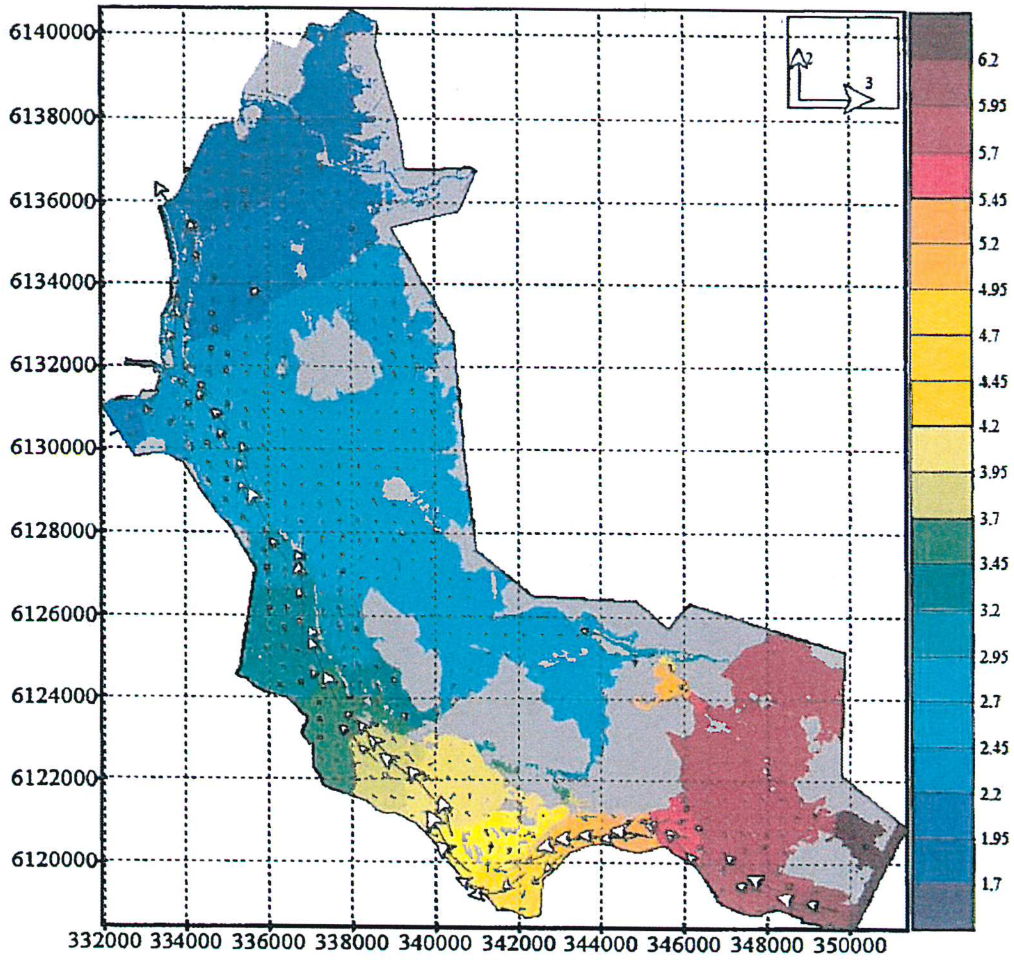

Fig. 7. Water level and velocity in full modeling domain. Scenario of 1979 year spring flood, reference case.

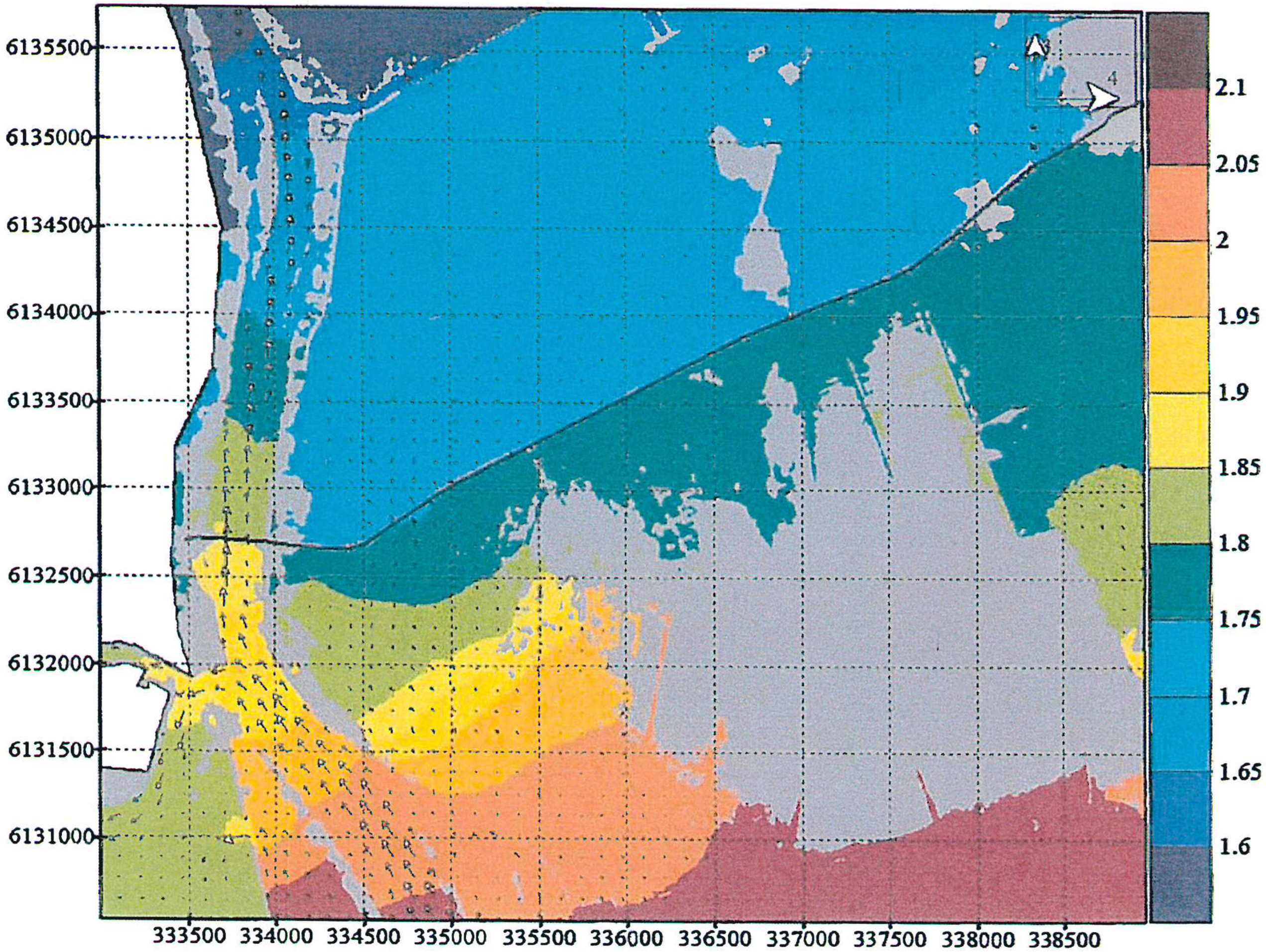

Fig. 8. Water level and velocity in vicinity of Šilute-Rusne road. 50% flood, reference case.

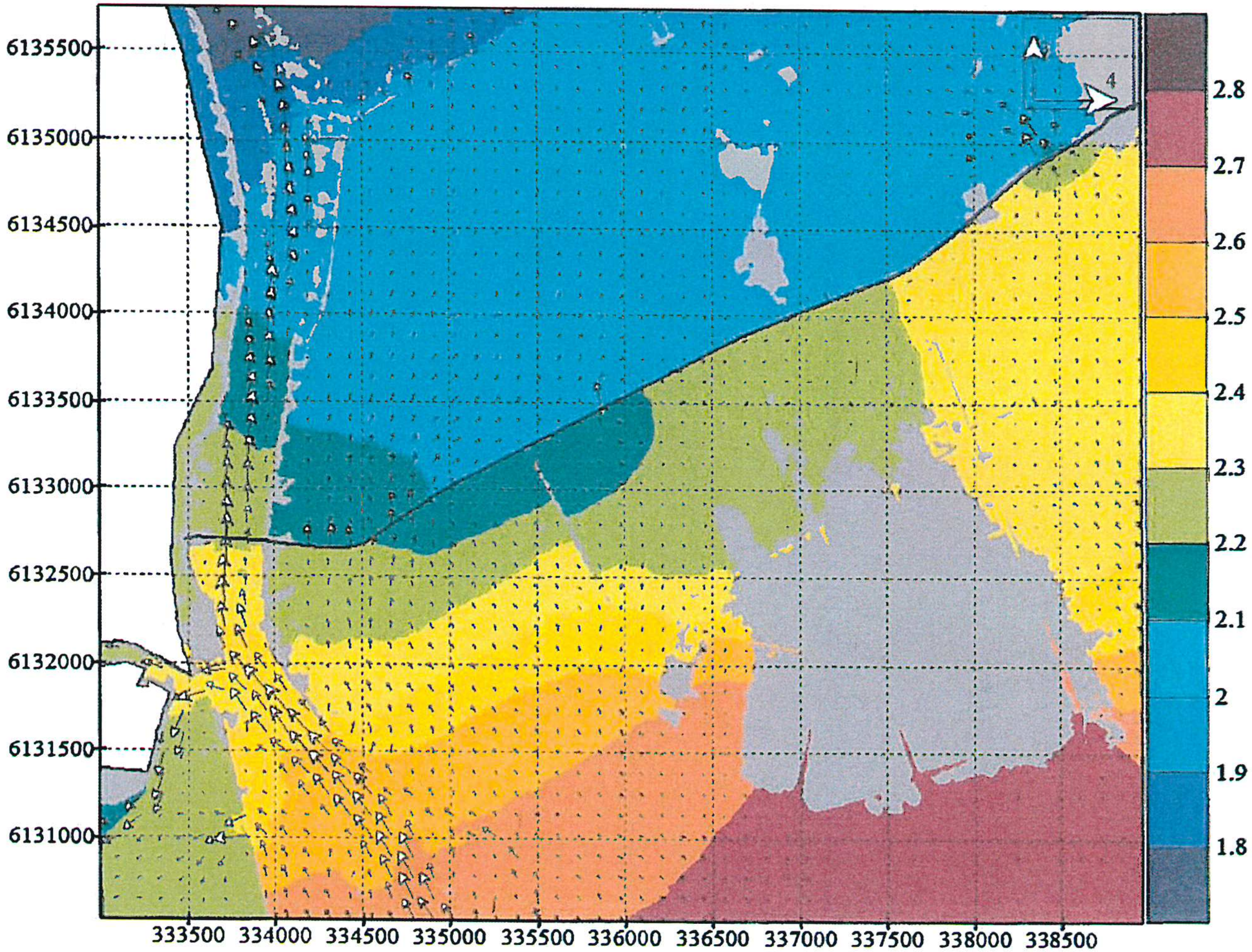

Fig. 9. Water level and velocity in vicinity of Šilute-Rusne road. 1979 year flood, reference case.

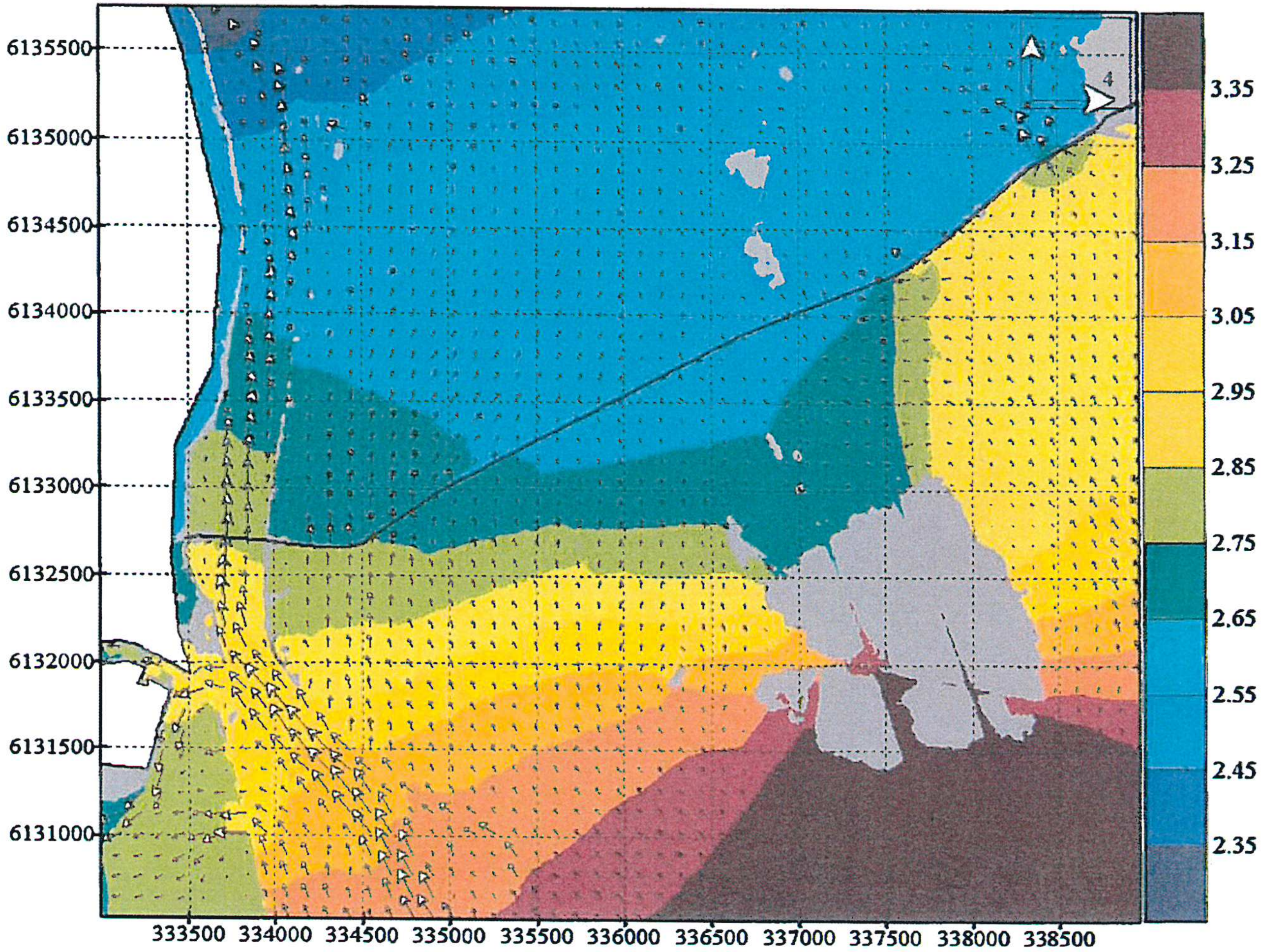

Fig. 10. Water level and velocity in vicinity of Šilute-Rusne road.. 1% flood, reference case.

Table 4. Discharges through different river branches and road sections for calculation cases.

CASE		Discharge															
		Skirvyte		Atmata		Road1		Viaduct		Road2		Žalgiriai		Griniaus bridge		Floodplain		Total
		m3/s	%	m3/s	%	m3/s	%	m3/s	%	m3/s	%	m3/s	%	m3/s	%	m3/s	%	m3/s
1%	reference	2067	35.1	1190	20.2	445	7.6	469	8.0	498	8.5	578	9.8	646	11.0	2637	44.7	5894
	proj1	2119	35.9	1222	20.7	405	6.9	371	6.3	533	9.0	587	10.0	656	11.1	2553	43.3	5894
	proj2	2112	35.8	1217	20.7	382	6.5	444	7.5	505	8.6	578	9.8	655	11.1	2565	43.5	5894
	proj3	2123	36.0	1189	20.2	315	5.3	475	8.1	508	8.6	638	10.8	646	11.0	2582	43.8	5894
	proj4	2515	42.7	1361	23.1	0	0.0	985	16.7	0	0.0	2	0.0	1031	17.5	2018	34.2	5894
	proj5	2404	40.8	1305	22.1	0	0.0	1212	20.6	0	0.0	2	0.0	971	16.5	2184	37.1	5894
1979	**observed**	**1363**	**38.9**	**947**	**27.0**							**0**	**0.0**	**305**	**8.7**	**1192**	**34.0**	**3502**
	calibration	**1403**	**40.1**	**942**	**26.9**	**177**	**5.1**	**408**	**11.7**	**149**	**4.2**	**6**	**0.2**	**417**	**11.9**	**1157**	**33.0**	**3502**
	proj1	1438	41.0	960	27.4	168	4.8	321	9.2	172	4.9	15	0.4	429	12.3	1105	31.6	3502
	proj2	1427	40.8	954	27.3	143	4.1	399	11.4	143	4.1	10	0.3	426	12.2	1120	32.0	3502
	proj3	1468	41.9	993	28.4	28	0.8	511	14.6	23	0.7	15	0.4	463	13.2	1041	29.7	3502
	proj4	1461	41.7	971	27.7	0	0.0	572	16.3	0	0.0	1	0.0	498	14.2	1071	30.6	3502
	proj5	1433	40.9	950	27.1	0	0.0	641	18.3	0	0.0	1	0.0	478	13.6	1120	32.0	3502
50%	reference	753	47.0	565	35.2	0	0.0	171	10.7	0	0.0	0	0.0	114	7.1	285.1	17.8	1603
	proj1	769	48.0	574	35.8	0	0.0	135	8.4	0	0.0	0	0.0	125	7.8	259.9	16.2	1603
	proj2	757	47.2	567	35.4	0	0.0	163	10.1	0	0.0	0	0.0	116	7.2	278.7	17.4	1603
	proj3	755	47.1	570	35.5	0	0.0	161	10.0	0	0.0	0	0.0	117	7.3	277.9	17.3	1603
	proj4	757	47.2	567	35.4	0	0.0	163	10.2	0	0.0	0	0.0	116	7.2	278.9	17.4	1603
	proj5	755	47.1	562	35.0	0	0.0	171	10.7	0	0.0	0	0.0	115	7.2	287	17.9	1603

Table 5. Water levels at different locations (incl. road sections) for calculation cases.

CASE		Water level, m				
		Atmata (station)	Atmata (bridge)	Viaduct	Žalgiriai	Griniaus bridge
1%	reference	2.98	2.83	2.72	2.62	2.76
	proj1	2.98	2.82	2.77	2.62	2.76
	proj2	2.98	2.82	2.76	2.62	2.76
	proj3	2.98	2.82	2.76	2.62	2.76
	proj4	3.03	2.84	2.91	3.18	2.93
	proj5	3.02	2.84	2.89	3.12	2.89
1979	**Observed**	**2.40**	-	**2.23**	**2.20**	**2.18**
	Calibration	**2.44**	**2.30**	**2.19**	**2.29**	**2.25**
	proj1	2.45	2.31	2.25	2.30	2.25
	proj2	2.45	2.31	2.23	2.30	2.25
	proj3	2.45	2.31	2.25	2.30	2.26
	proj4	2.46	2.32	2.28	2.45	2.30
	proj5	2.46	2.31	2.26	2.43	2.29
50%	Reference	1.93	1.85	1.75	1.78	1.76
	proj1	1.93	1.85	1.79	1.80	1.77
	proj2	1.93	1.85	1.76	1.79	1.76
	proj3	1.93	1.85	1.76	1.79	1.76
	proj4	1.93	1.85	1.76	1.79	1.76
	proj5	1.93	1.85	1.76	1.77	1.76

(e) The medium high (200-300 cm) straight section of road (referred as "Žalgiriai").

(f) The Griņius bridge and associated viaduct. There is no permanent watercourse beneath the Griņius bridge.

During any of flood events the Nemunas flow may be considered as concentrated

(1) In the riverbeds. This flow pattern is partly isolated form the flow in the floodplain by the dams.

(2) In the floodplain northeast from the Žalgiriai, This flow originates from the main Nemunas flow upstream the Leite confluence and flows towards sea through the Griņius bridge.

(3) In the floodplain southwest from the Žalgiriai. This flow originates from the main Nemunas flow downstream the Leite confluence and flows towards sea over the lowest stretch of the Šilute – Rusne road.

The water is mostly stagnant in the other parts of the floodplain.

Table 6. Water velocities at different locations (incl. road sections) for calculation cases.

CASE		Water velocity, m/s			
		Atmata (bridge)	Road1	Viaduct	Griniaus bridge
1%	reference	1.61	1.52	1.00	1.81
	proj1	1.69	2.34	1.52	1.85
	proj2	1.69	2.19	1.09	1.85
	proj3	1.71	2.42	1.21	1.88
	proj4	1.88	0.00	2.31	2.95
	proj5	1.82	0.00	1.86	2.83
1979	**observed**	**1.46**	**0.83**	**0.78**	**1.03**
	calibration	**1.47**	**2.08**	**1.15**	**1.74**
	proj1	1.53	3.21	2.26	1.79
	proj2	1.51	2.87	1.25	1.78
	proj3	1.52	1.51	1.45	1.84
	proj4	1.55	0.00	1.71	2.04
	proj5	1.52	0.00	1.17	1.99
50%	reference	1.01	0.00	1.00	0.74
	proj1	1.03	0.00	1.89	0.79
	proj2	1.05	0.00	0.66	0.76
	proj3	1.05	0.00	0.65	0.76
	proj4	1.05	0.00	0.67	0.76
	proj5	1.05	0.00	0.47	0.76

During the 50% flood the flow in the main river channels is rather well separated from the floodplain (Fig. 8) except for the confluences of tributaries. The dams along the Šyša river are above water. The water level at the Šilute-Rusne road is 175-180 cm (Table 4). Only the lowest road stretch at the proposed viaduct site is overtopped (Fig. 11), and flow velocity there does not exceed 1 m/s. Almost half (47%) of the Nemunas discharge flows through Skirvyte, contribution of floodplain is just 18% of the total flow volume (Fig. 14). 60% of the floodplain flow goes over the lowest stretch of the road, whilst 40% - beneath the Griņius bridge (Fig. 15). Large parts of the Žalgiriai forest are above the water (Fig. 8).

During the 10% flood (approximately equal to spring flood 1979) the flow in the main river channels are still separated from the floodplain (Fig. 9). The dams along the Šyša river are, however, below the water. The water level at the Šilute-Rusne road is 220-225 cm (Table 4). Road stretches "road1", "road2" as well as the lowest road stretch at the proposed viaduct site is overtopped (Fig. 12). The share of the Nemunas flow over the floodplain increases to 33% (Fig. 14). Most (70% in total) of the floodplain flow goes over the lowest stretch of the road and beneath the Griņius bridge (Fig. 15). Central part of the Žalgiriai forest is above the water (Fig. 9).

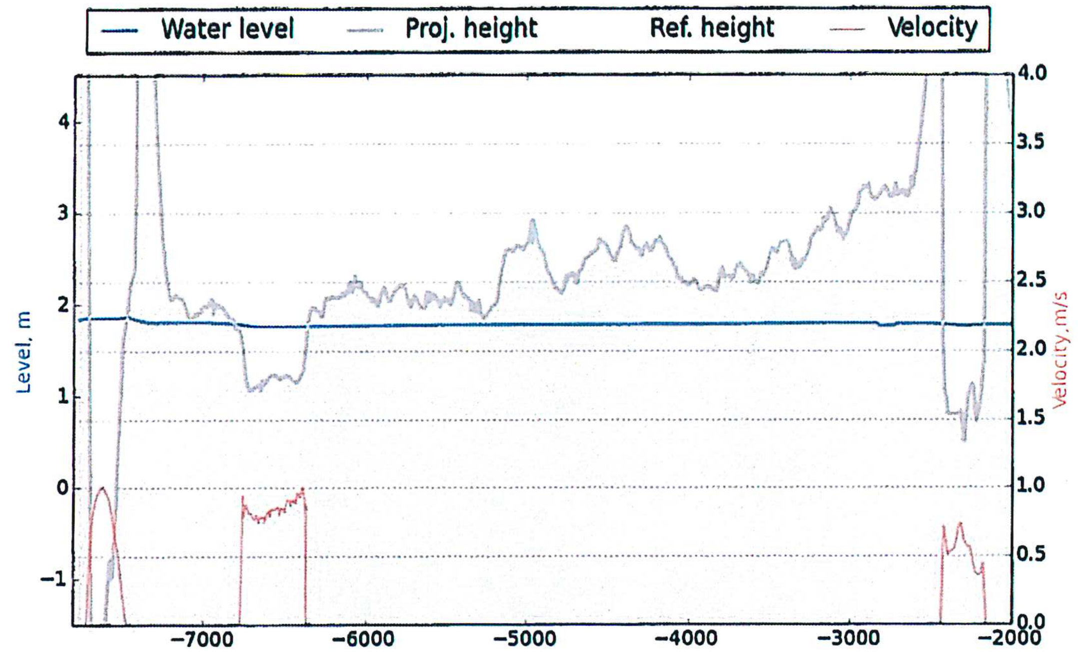

Fig.11. Road profile, waterlevel and flow velocity. 50% flood, reference case.

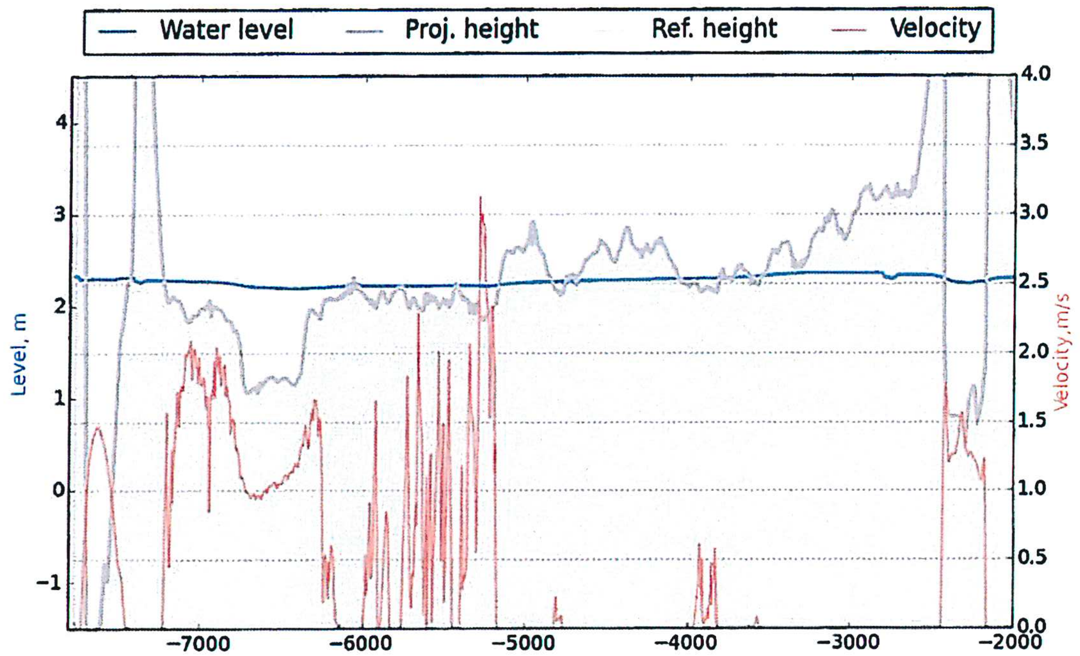

Fig. 12. Road profile, waterlevel and flow velocity. 1979 year flood, reference case.

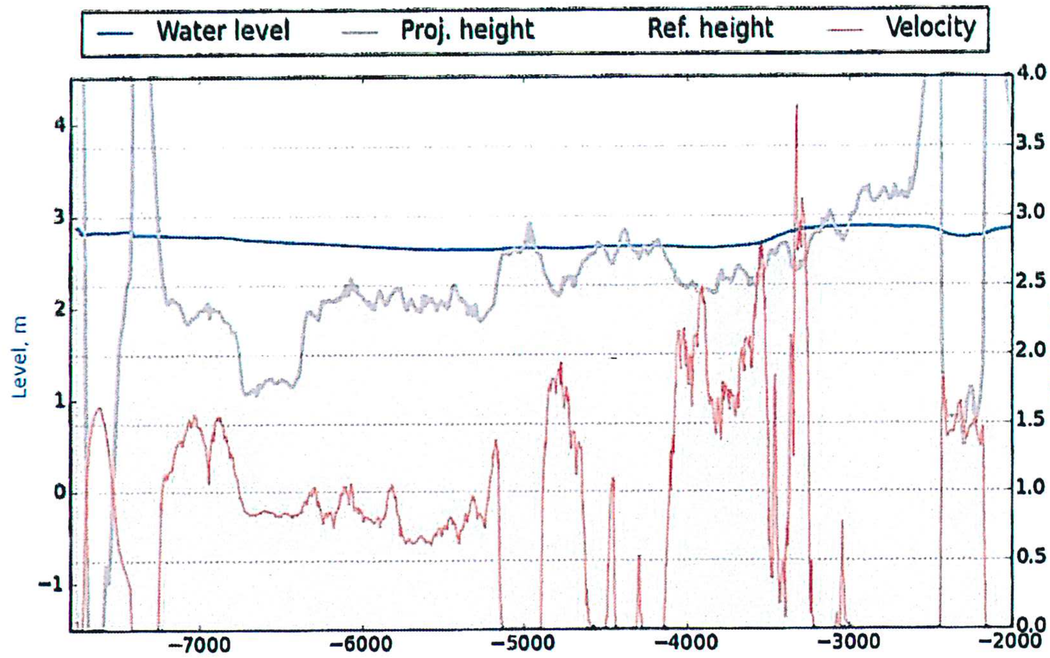

Fig. 13. Road profile, waterlevel and flow velocity. 1% flood, reference case.

During the 1% flood the flow in the main river channels is poorly separated from the floodplain (Fig. 10). The water level at the Šilute-Rusne road is 260-275 cm (Table 4). Road is completely overtopped between the Atmata and Griņius bridges (Fig. 13). The flow velocity varies significantly (Fig.13, Table 5) depending on water dept. The share of the Nemunas flow over the floodplain increases further, reaching 45% (Fig. 14). The flow over segments of overtopped road are distributed rather evenly (Fig. 15). Most of the Žalgiriai forest is below the water (Fig. 10).

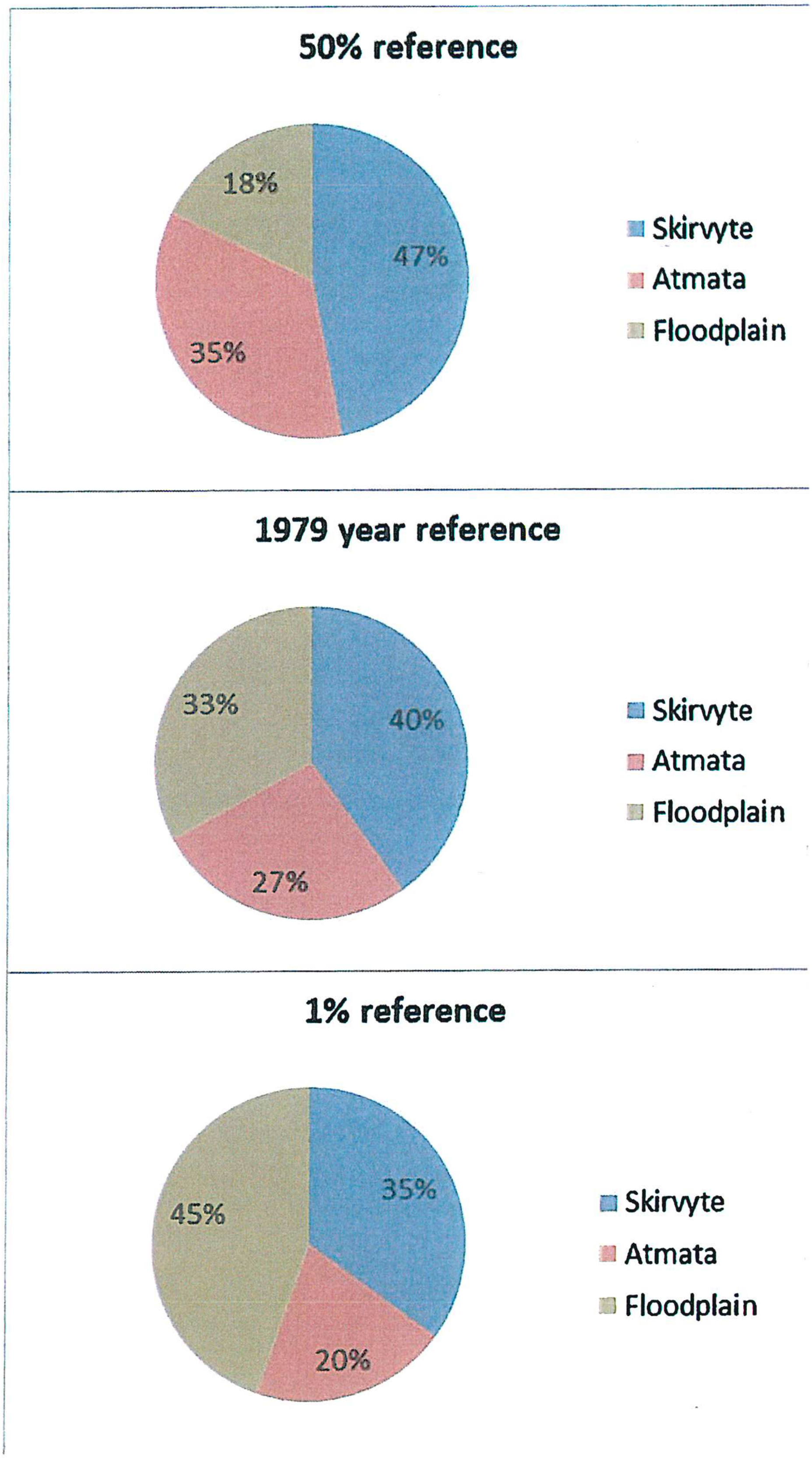

Fig. 14. Discharge distribution for 50% flood, spring flood 1979 and 1% flood between flow branches.

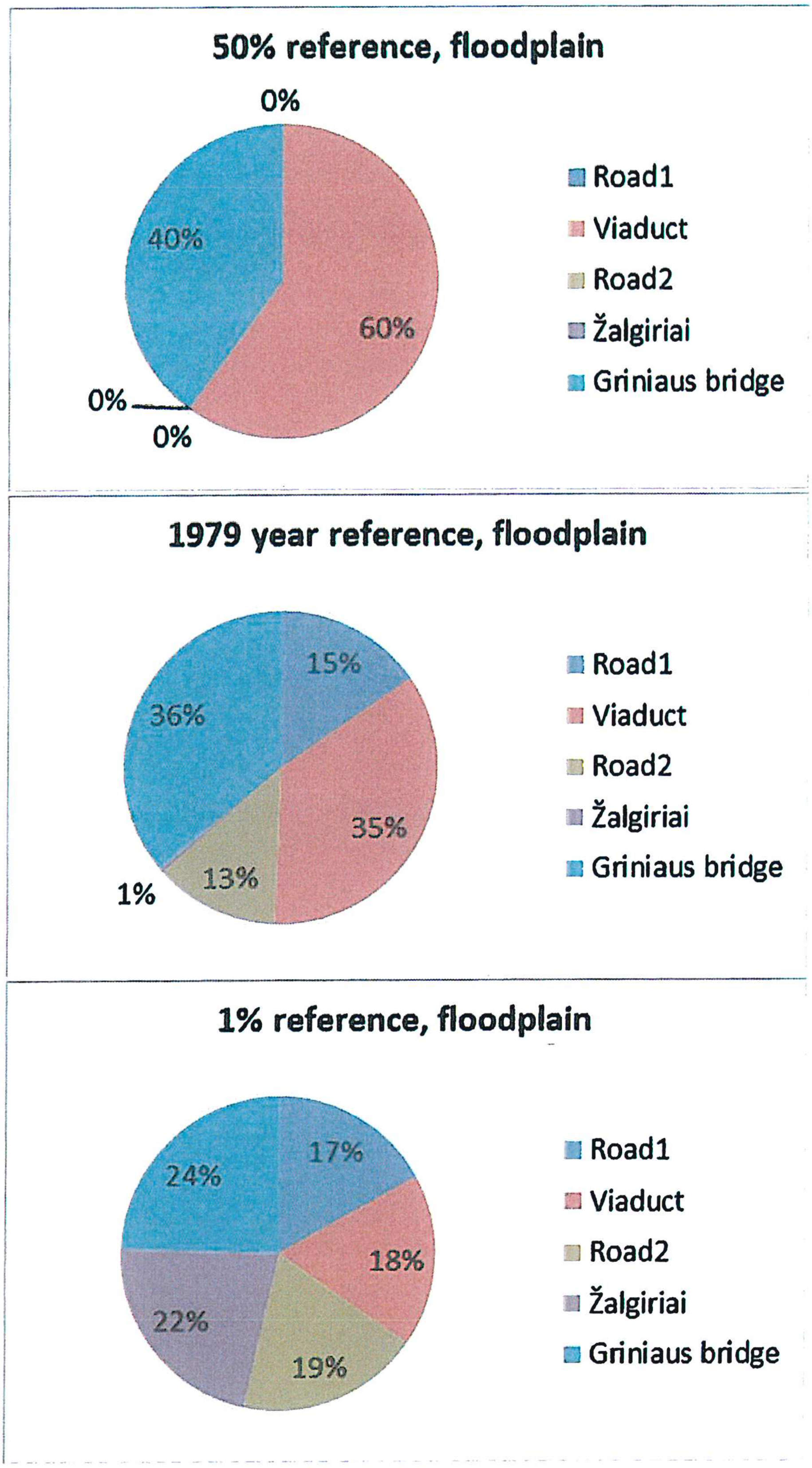

Fig. 15. Floodplain discharge distribution for 50% flood, spring flood 1979 and 1% flood between the over segments of Šilute-Rusne road.

3.2. ALTERNATIVES OF VIADUCT SOLUTIONS

The five alternatives of the viaduct design aimed at reduction (prevention) of the overtopping of Šilute – Rusne road are considered for hydrodynamical case studies. These alternatives are chematically shown in Fig. 16.

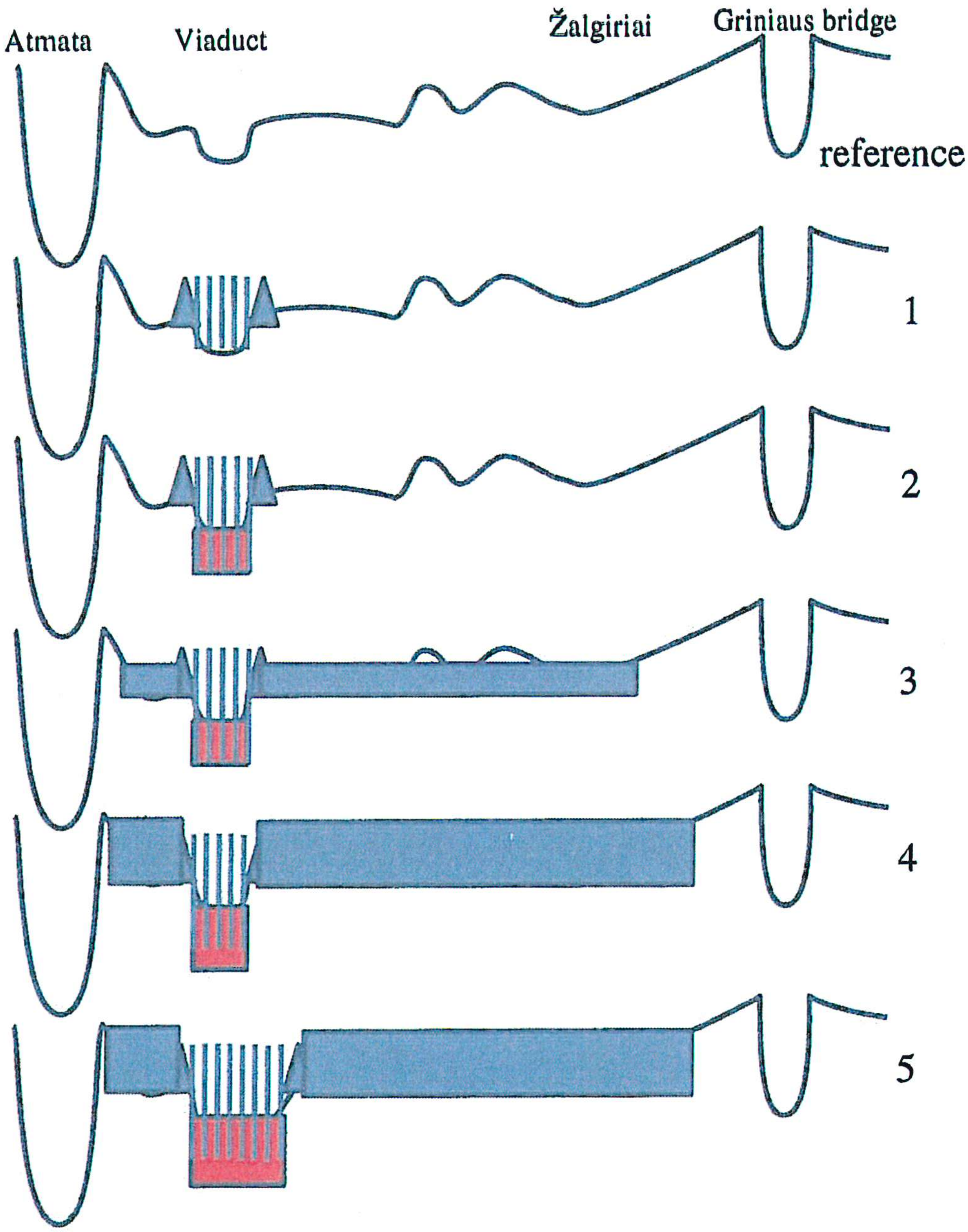

Fig. 16. Schematisation of considered viaduct alternatives.

1. Alternative "proj1" assumes building a 400 m long viaduct over the lowest stretch of the road. This alternative aims at prevention of the road overtopping during 50% flood.

2. Alternative "proj2" combines the 1st alternative with the lowering of the road section beneath the viaduct to the level of surrounding terrain (20 cm a.s.l.). This alternative also aims at prevention of the road overtopping during 50% flood but in the same time enhances the water flow beneath the new structure thus preventing its impact on the water level raise.

3. Alternative "proj3" combines the 2nd alternative with the raising of the road stretches "road1" and "road2" to the level 220 cm a.s.l. This alternative guarantees the defense against the floods which exceed 50% probability for the most vulnerable stretches of the road.

4. Alternative "proj4" combines the 3rd alternative with the raising of the whole road Šilute-Rusne to the 4 m level. This alternative is aimed for the prevention of the road overflow during the 1% flood situations.

5. Alternative "proj5" is a variation of alternative "proj4" with prolonged viaduct (700 m instead of 400 m). Such an alternative is considered to facilitate a discharge of water at low probability floods through the viaduct.

3.3. CASE STUDIES FOR VIADUCT ALTERNATIVES

Five modifications of the digital terrain model and calculation mesh were performed according to the alternative configurations / parameters of the proposed viaduct (Section 3.2). For each of the design alternatives the calculations of 50% flood, spring flood 1979 and 1% flood were done. The results of these calculations are presented as

- Discharge values through Nemunas branches and different segments of the Šilute-Rusne road for all scenarios and cases in Table 4.

- Water levels (Table 5) and flow velocities (Table 6) at different locations – under Atmata bridge, under the proposed viaduct and the Griņius bridge.

- Longitudinal profile of Šilute-Rusne road with waterlevels and flow velocities for all design cases and all flood scenarios in, respectively, Figs. 17-31.

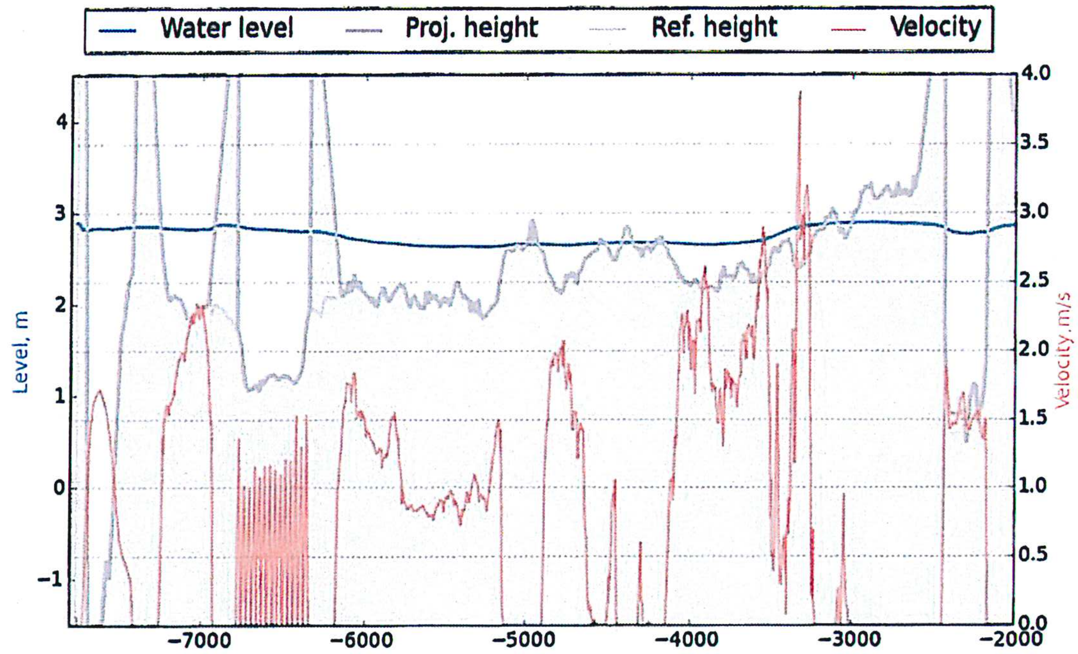

Fig. 17. Road profile, waterlevel and flow velocity. 1% flood, case "proj1"

The alternative "proj1" solves the most important problem of exploitation of the road "Šilute-Rusne" – protection of the lowest road section, see Figs. 17-19. The water level near the viaduct raises by approximately 5 cm (Table 5). It does not prevent overtopping of the road stretches "road1" (by 30 cm) and "road2" (by 20 cm) during the 10% floods, see Fig. 18. The construction only slightly changes the water balance reducing the floodplain share of overall Nemunas flow by 1.5% (Table 4). The water velocity changes insignificantly both in Atmata under the main bridge (by 2 to 8 cm/s) and under the Griņius bridge (by 5 cm/s), see Table 6. The water velocity under the viaduct may reach 2.6 m/s during the 10% flood (Fig. 18).

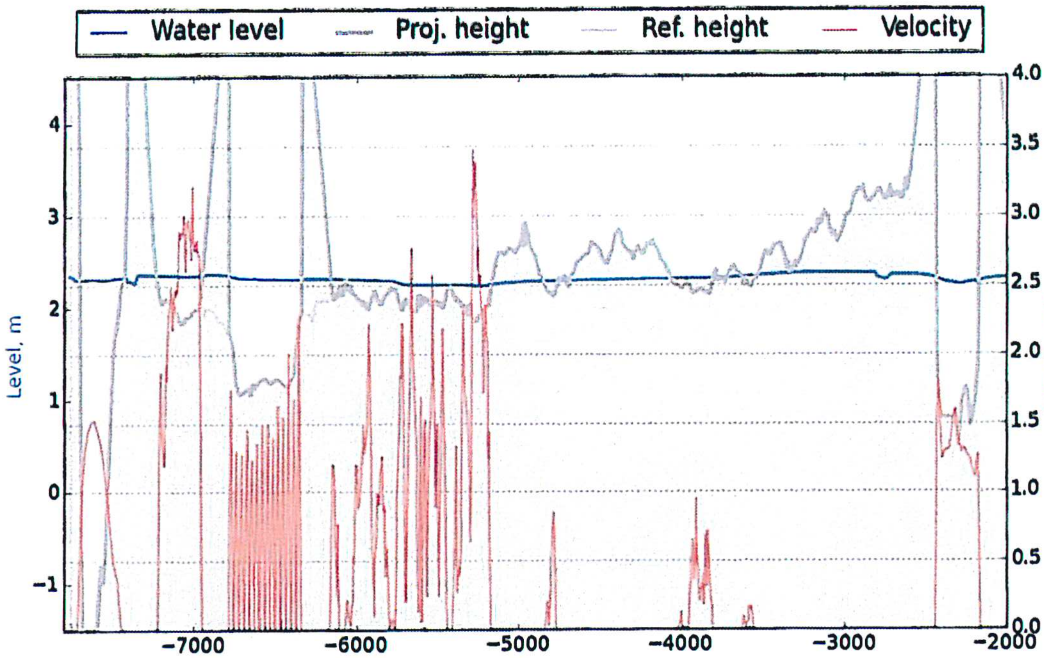

Fig. 18. Road profile, waterlevel and flow velocity. 1979 year flood, case "proj1".

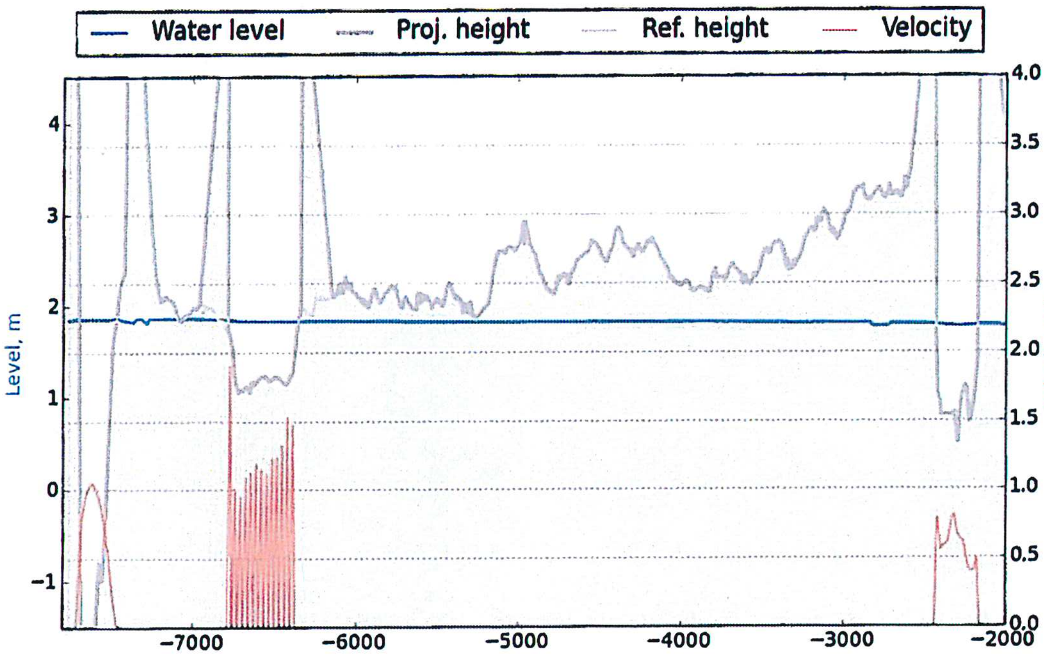

Fig. 19. Road profile, waterlevel and flow velocity. 50% flood, case "proj1".

The alternative "proj2" (Figs. 20-22) is aimed to facilitate the water flow beneath the new viaduct. The water level near the viaduct is almost the same as in "proj1" (Table 5). The water balance is restored to reference situation for 50% flood; reduction of the floodplain share of overall Nemunas flow for this scenario is only 0.4% (Table 4). The water velocity under the viaduct is reduced to 1.25 m/s during the 10% flood

(Table 5, Fig. 21). The total discharge through the viaduct is restored to almost the same discharge as over that road stretch in the reference situation (Table 4).

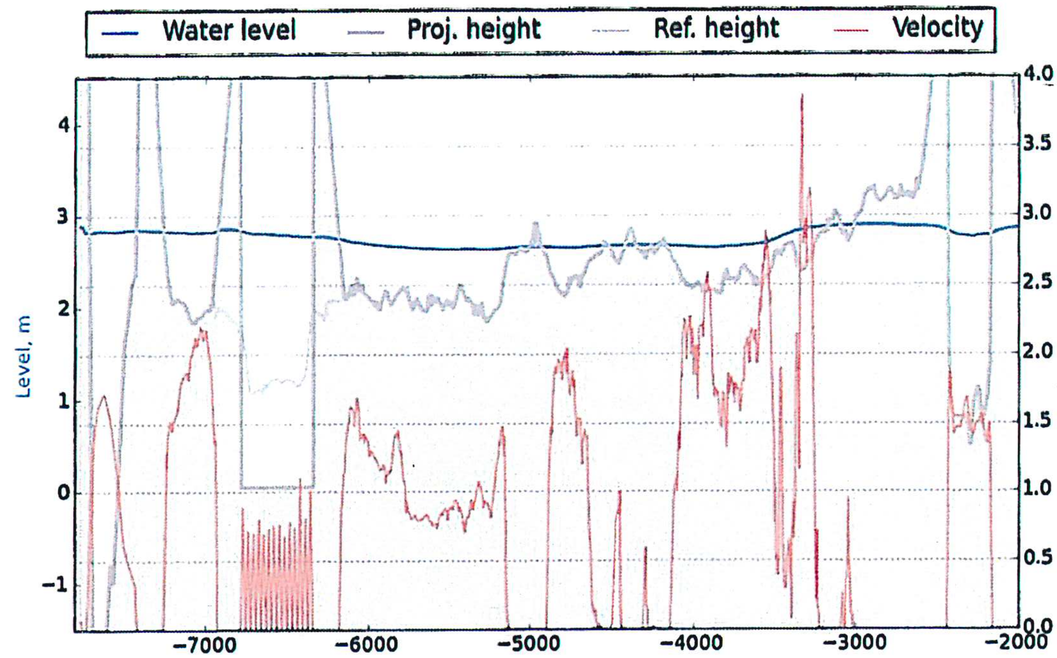

Fig. 20. Road profile, waterlevel and flow velocity. 1% flood, case "proj2".

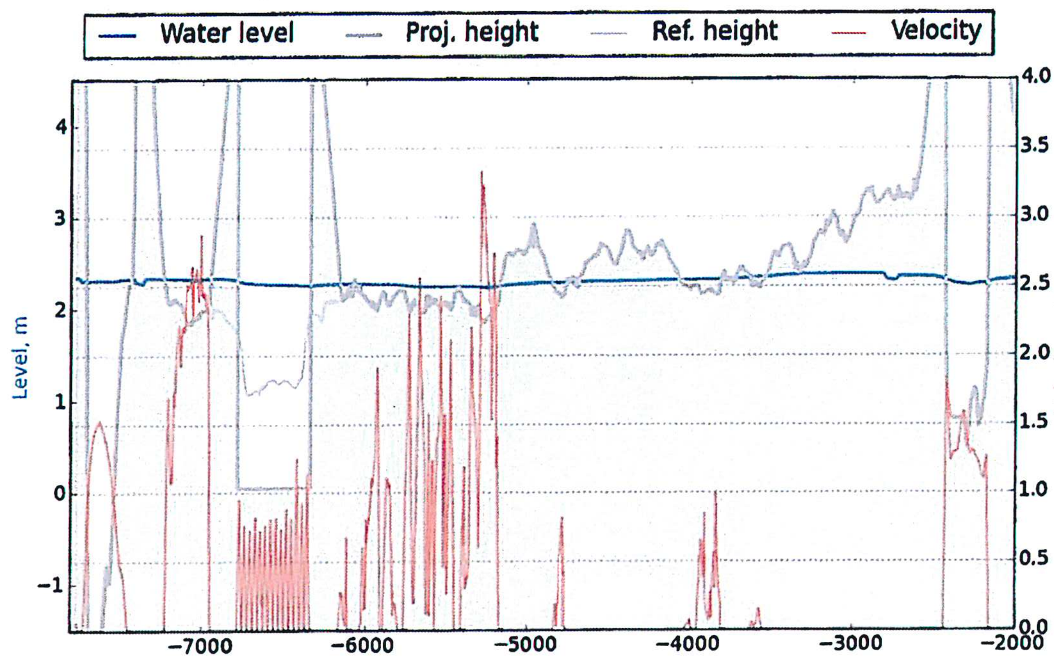

Fig. 21. Road profile, waterlevel and flow velocity. 1979 year flood, case "proj2".

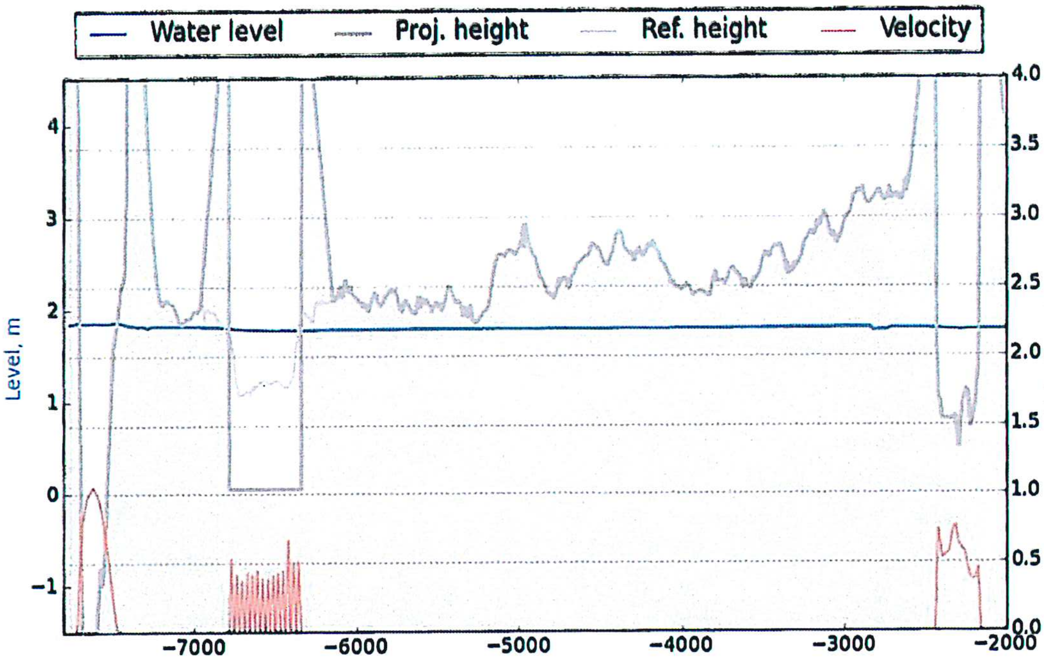

Fig. 22. Road profile, waterlevel and flow velocity. 50% flood, case "proj2".

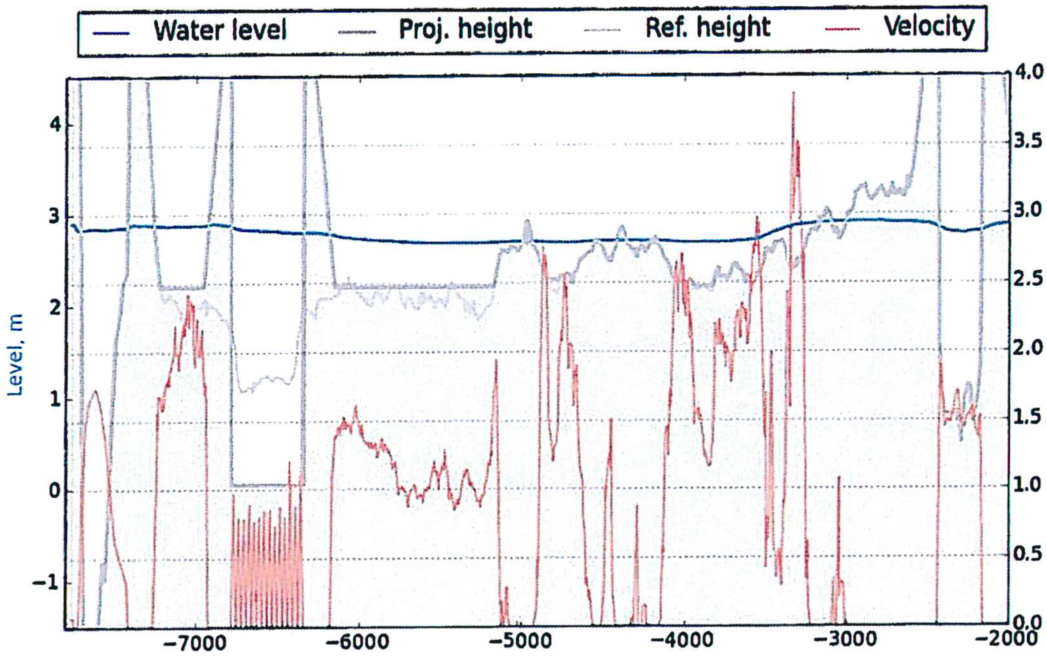

Fig. 23. Road profile, waterlevel and flow velocity. 1% flood, case "proj3".

The alternative "proj3" (Fig. 23-25) is aimed for improving the situation in the most vulnerable stretches of road "Šilute-Rusne" protecting them for the floods of probability below 50%. This alternative does not change the situation (in comparison with "proj2") for 50% flood. The situation changes most significantly for medium (10%) floods; the depth of overtopping of the road in this case is below 20 cm. The overall flow through the floodplain reduces by 3.3% of total Nemunas discharge in comparison with the reference situation (Table 4). The water level and velocity elsewhere changes negligibly (Tables 5-6).

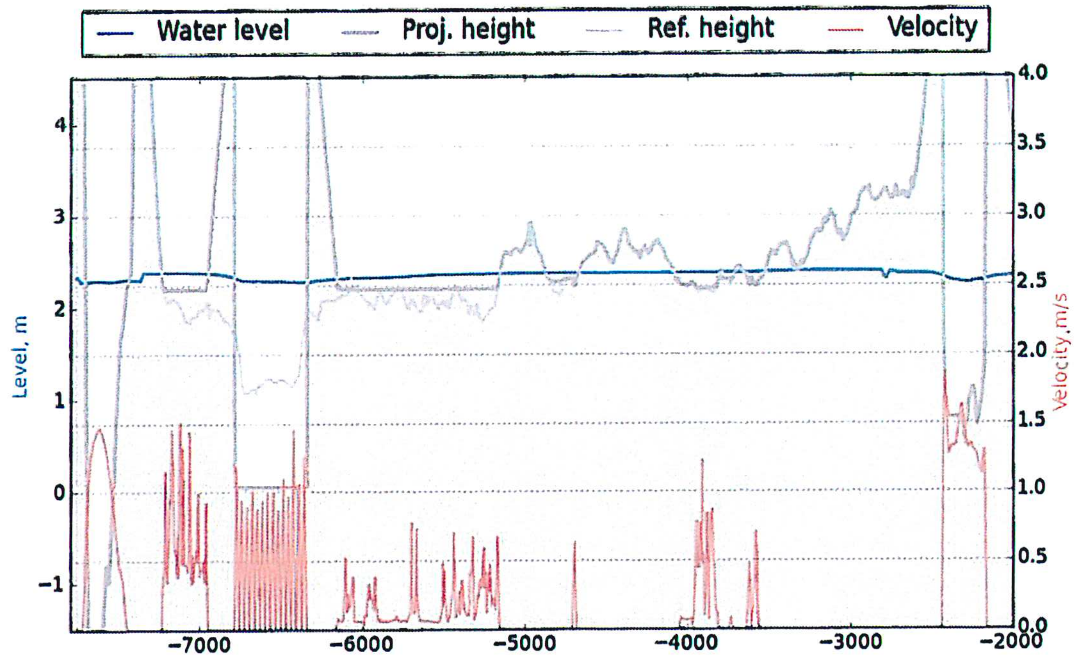

Fig. 24. Road profile, waterlevel and flow velocity. 1979 year flood, case "proj3".

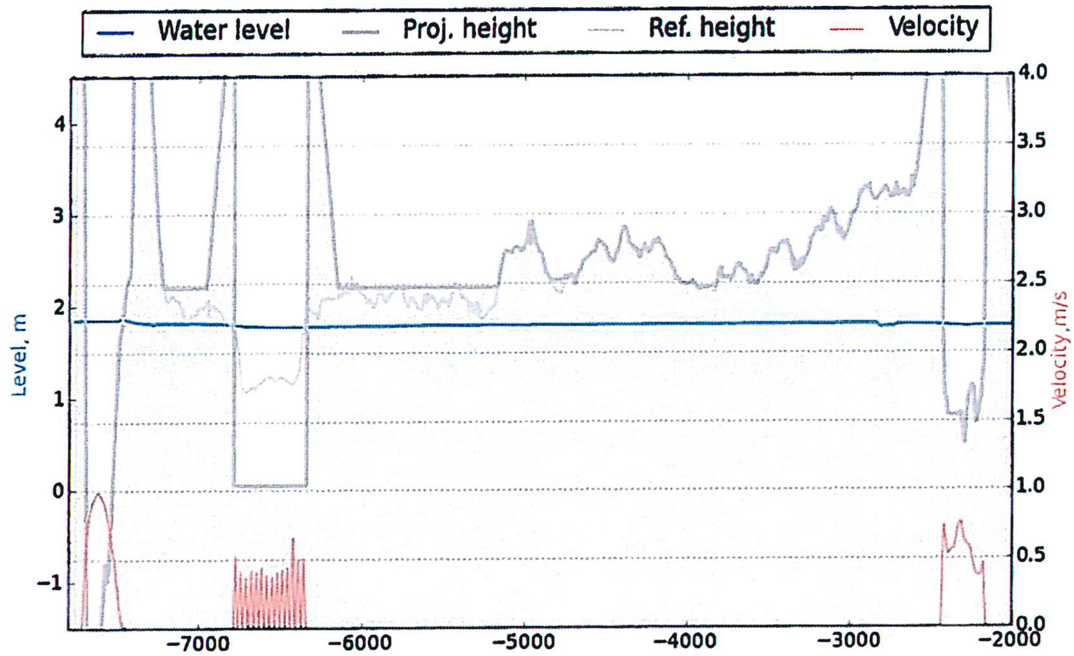

Fig.25. Road profile, waterlevel and flow velocity. 50% flood, case "proj3".

The alternative "proj4" is aimed for the protection of overtopping of the road "Šilute-Rusne" during 1% flood events, see Figs. 26-28. Blocking the road overtopping leads to the following consequences:

- Change of the floodplain flow volume in 1% floods (Table 4). The flow through the floodplain is reduced by 10.5% of the total Nemunas flow. This volume is diverted to Skirvyte (above 70%) and Atmata (below 30%).

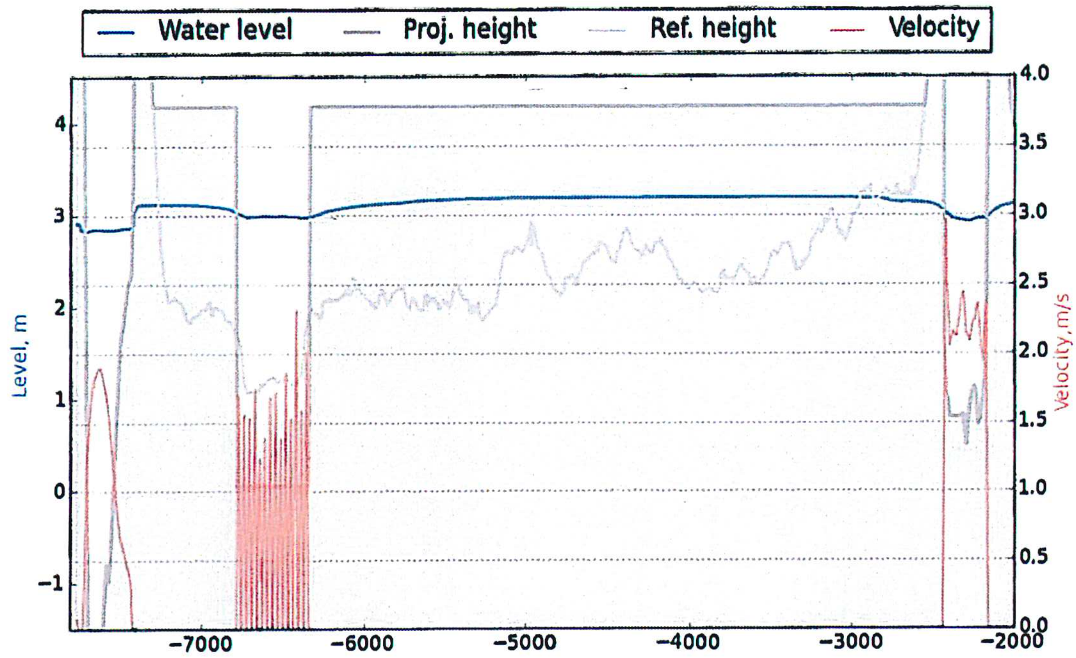

Fig. 26. Road profile, waterlevel and flow velocity. 1% flood, case "proj4".

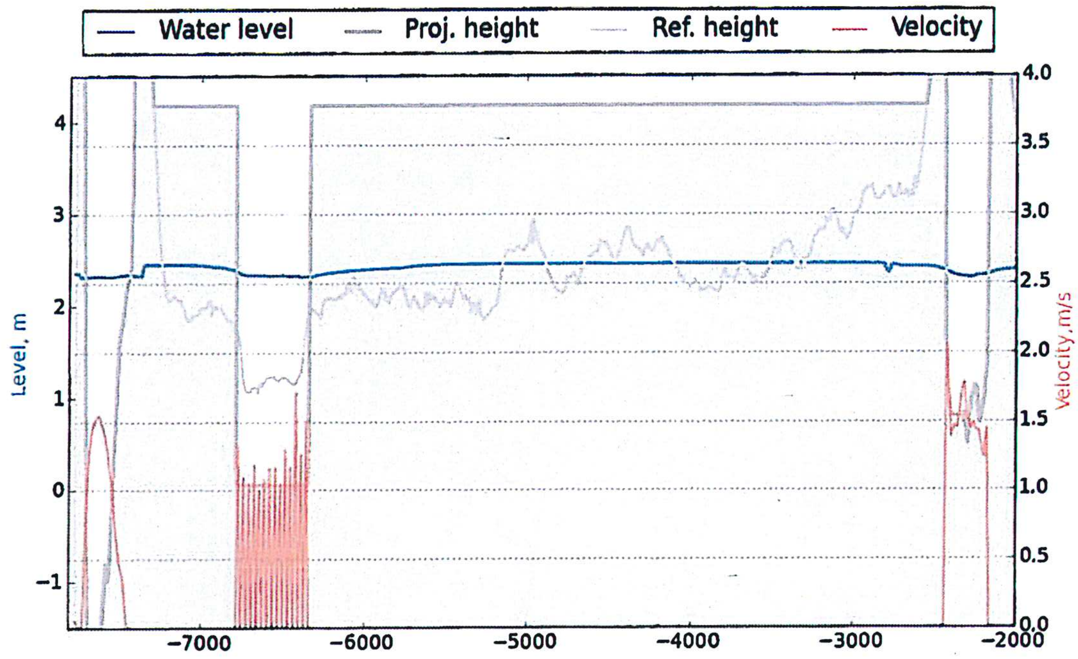

Fig. 27. Road profile, waterlevel and flow velocity. 1979 year flood, case "proj4".

- The discharge through the viaduct more than doubles but through Griņius bridge increases by more than 50% for 1% flood (Table 4).

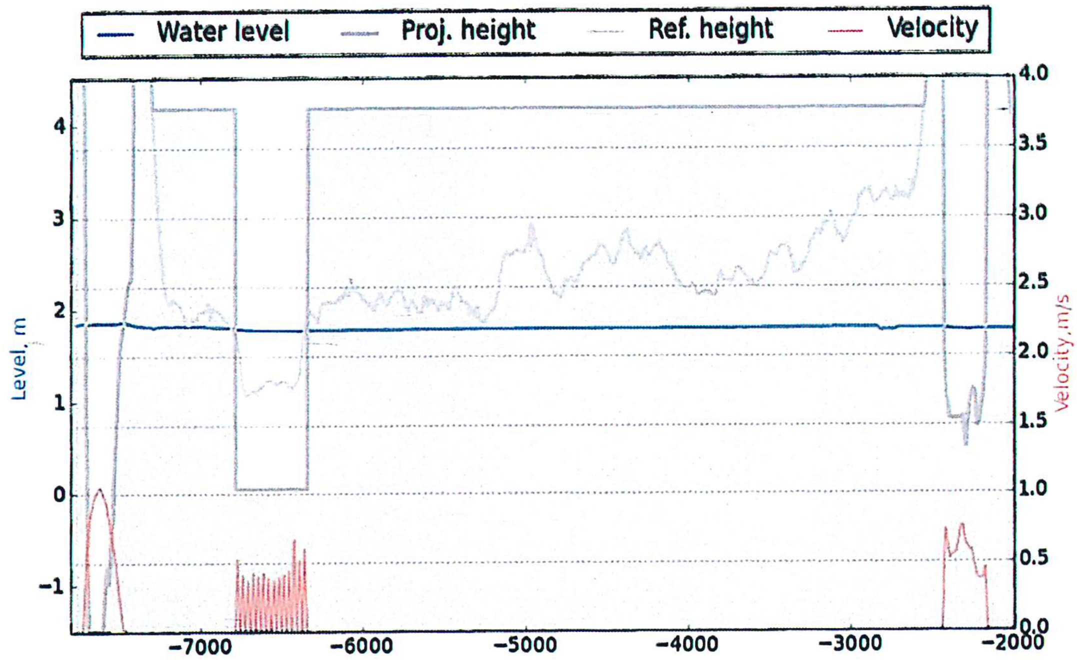

Fig.28. Road profile, waterlevel and flow velocity. 50% flood, case "proj4".

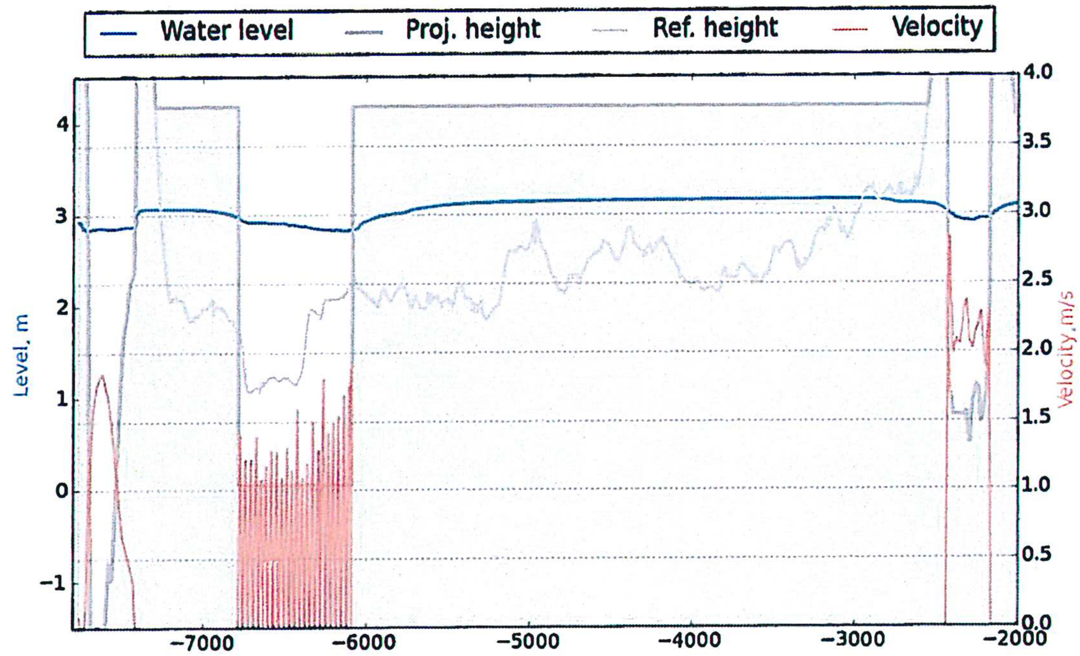

Fig. 29. Road profile, waterlevel and flow velocity. 1% flood, case "proj5".

- As a consequence of above the flow velocity under the constructions increases significantly comparing to reference cases (Table 6) during 1% flood: (a) from 1.6-1.7 m/s to 1.9 m/s beneath the main Atmata bridge; (b) from 1.1-1.2 m/s to 2.3 m/s under the viaduct; (c) from 1.8-1.9 m/s to 3 m/s under the Griņius bridge. These velocities may be critical for the constructions.

- The water level in 1% event raises by 15 cm at the viaduct, by 56 cm in Žalgiriai and by 27 cm at the Grinius bridge (Table 5).

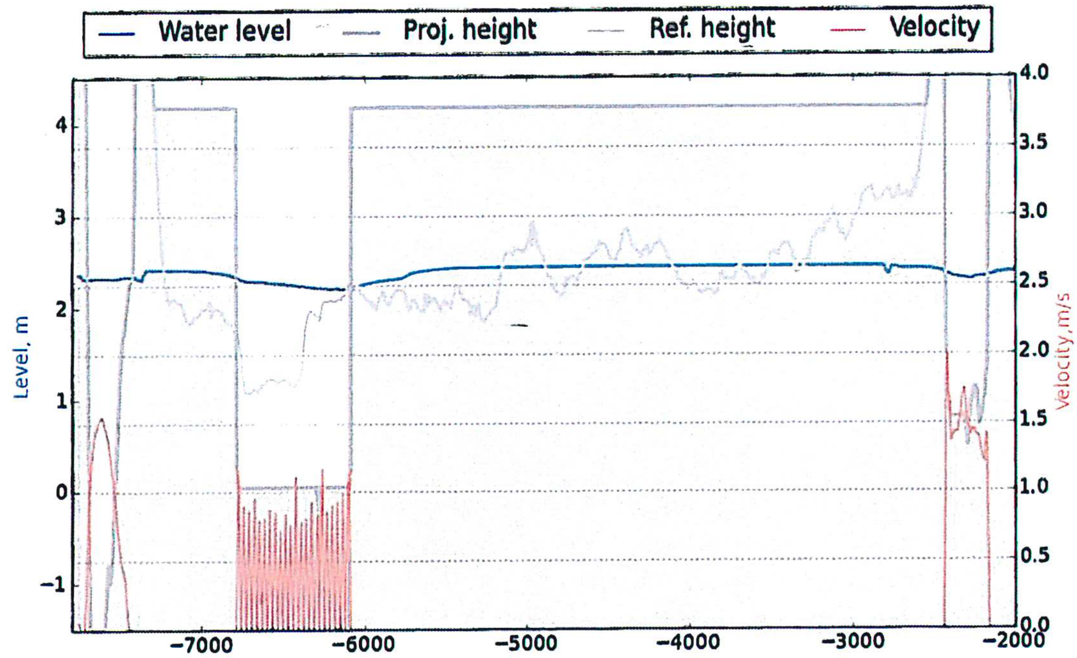

Fig. 30. Road profile, waterlevel and flow velocity. 1979 year flood, case "proj5".

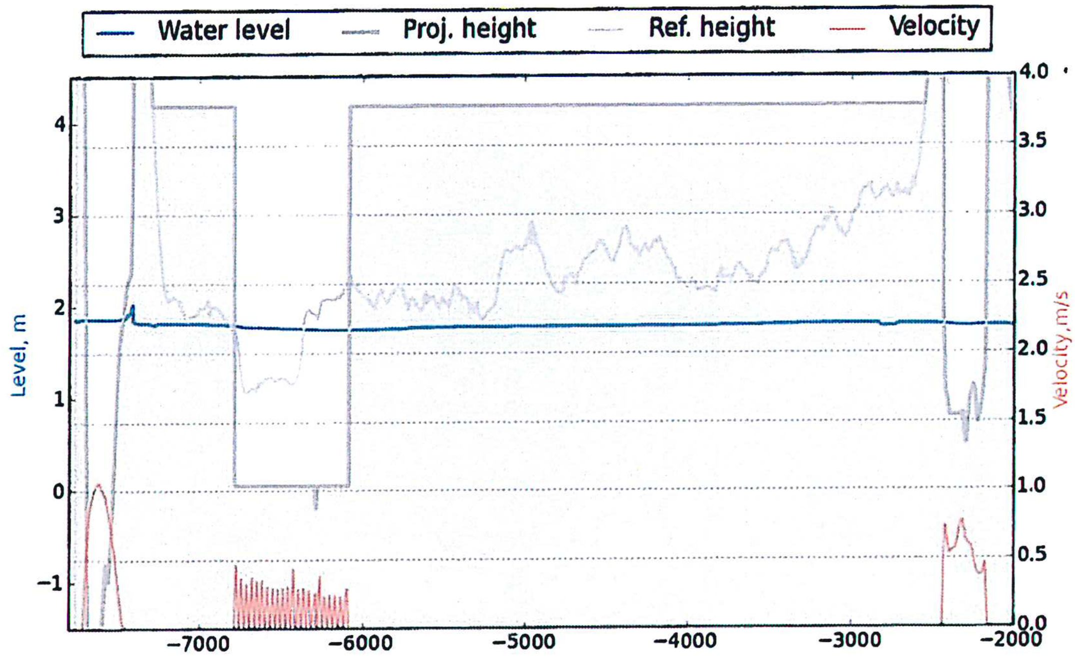

Fig. 31. Road profile, waterlevel and flow velocity. 50% flood, case "proj5".

The alternative "proj5" is aimed for the protection of overtopping of the road "Šilute-Rusne" during 1% flood events and in the same time reducing the adverse affects of "proj4". It assumes increase of the viaduct length from 400 to 700 m to facilitate the discharge through it, see Figs. 29-31. The effects of "proj5" in comparison with "proj4" are as follows:

- Change of the floodplain flow volume in 1% floods (Table 4) is reduced by 7.5% of the total Nemunas flow (10.5% for "proj4"). The discharge through the viaduct almost triples in comparison with "proj2" and raises by 50% in comparison with "proj4" for 1% flood (Table 4).

- The increase of flow velocity under the constructions still increases significantly comparing to reference cases (Table 6) during 1% flood: (a) from 1.6-1.7 m/s to 1.8 m/s beneath the main Atmata bridge; (b) from 1.1-1.2 m/s to 1.9 m/s under the viaduct; (c) from 1.8-1.9 m/s to 2.8 m/s under the Griņius bridge.

- The water level in 1% event is lower than in "proj4": by 2 cm at the viaduct, by 6 cm in Žalgiriai. The increase of the waterlevel (50 cm) in comparison with reference case is still significant for Žalgiriai settlement.

3.4. Conclusions

The selection of the viaduct alternatives should be based on economic and social reasoning. The hydrodynamical modeling provides the evaluation of the consequences and effects of different solutions aiding and supporting the decision-making.

Basically the defence of road against frequent (50%) floods can be done without disturbing hydrodynamical regime of Nemunas in Vicinity of Rusne. It may be achieved by realizing alternative "proj2". The building of viaduct should be accompanied with removing of the "old" road beneath the viaduct (leveling it with the surrounding terrain) and eliminating the trees along this old road stretch.

The longitudinal profile of the road suggest a further step – "proj3", or slight elevating to 220 cm of the most vulnerable road stretches. This alternative only insignificantly changes the hydrodynamical conditions both at frequent (50%, road overtops in neither case) and in infrequent (1%, road overtops anyway) floods.

The increase of the road surface above the level of 1% flood significantly changes the hydrodynamics of floodplain during the low probability flood events. This causes several consequences which may be considered as dangerous: (a) essential reduction of the flow over floodplain and increase of flow in the main river channels, (b) significant increase of the water velocities beneath the existing (Atmata bridge, Griņius bridge) and proposed (viaduct) constructions, (c) the significant increase of the waterlevels in Žalgiriai settlement. These adverse consequences cannot be eliminating by reasonable increasing of the length of the proposed viaduct.